Isolated femoropopliteal bypass graft for limb salvage after failed tibial reconstruction: A viable alternative to amputation

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Purpose: **Femoropopliteal bypass grafting procedures performed to isolated popliteal arteries after failure of a previous tibial reconstruction were studied. The results were compared with those of a study of primary isolated femoropopliteal bypass grafts (IFPBs).**
Methods: **IFPBs were only constructed if the uninvolved or patent popliteal segment measured at least 7 cm in length and had at least one major collateral supplying the calf. When IFPB was performed for ischemic lesions, these lesions were usually limited to the digits or small portions of the foot. Forty-seven polytetrafluoroethylene grafts and three autogenous reversed saphenous vein grafts were used.**
Results: **Ankle brachial pressure index (ABI) increased after bypass grafting by a mean of 0.46. Three-year primary life table patency and limb-salvage rates for primary IFPBs were 73% and 86%, respectively. All eight IFPBs performed after failed tibial bypass grafts remained patent for 2 to 44 months, with patients having viable, healed feet.**
Conclusion: **In the presence of a suitable popliteal artery and limited tissue necrosis, IFPB can have acceptable patency and limb-salvage rates, even when a polytetrafluoroethylene graft is used. Secondary IFPB can be used to achieve limb salvage after failed tibial bypass grafting. (J Vasc Surg 1999;29:409-12.)**

Limb-threatening ischemia often results when a distal tibial bypass graft fails and circulation cannot be restored by means of revision, lytic therapy, or a new distal bypass graft. The presence of an isolated popliteal artery that could still be used for limb salvage may be overlooked, or an isolated femoropopliteal bypass grafting procedure may not be performed because of prejudice against this procedure.

Eight secondary isolated popliteal bypass grafting procedures were performed after failed tibial reconstructions, and the results for these secondary bypass grafts were compared with those of 42 primary bypass grafts to isolated popliteal arteries.

METHOD AND RESULTS

General experience with isolated femoropopliteal bypass grafts. Arteriographic evaluation and color duplex scans preceded all isolated femoropopliteal bypass grafts (IFPBs). These grafts were only constructed if the uninvolved or patent popliteal segment measured at least 7 cm in length and had at least one major collateral supplying the calf. The position of the isolated segment above or below the knee did not impact the decision to use that vessel.

Primary isolated femoropopliteal bypass grafts. Primary IFPBs constituted 8.5% of the femoropopliteal bypass grafting procedures performed by our group. The indications for primary IFPB were gangrene in 13 patients (31%), nonhealing ulceration in 12 patients (29%), rest pain in eight patients (19%), and claudication in nine patients (21%). Primary IFPB was usually performed only when gangrene or nonhealing ulceration was limited to the digits or a small portion of the heel or foot (usually patches of less than 1 cm). The mean age of the patients was 72 years (range, 46 to 90 years). Twenty-five of the patients were men (60%), and 17 were women (40%). As in our general population of infrainguinal reconstructions, most patients had comorbid conditions, such as diabetes in 35 patients (83%), coronary artery disease in 26 patients (62%), hypertension in 17 patients (40%), and a history of

From Vascular and Surgery Associates.
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0741-5214/99/$8.00 + 0 **24/1/94365**

smoking in 32 patients (76%). The IFPB grafts were constructed to the above-knee segment in 23 patients (55%) and the below-knee segment in 19 patients (45%).

For the primary IFPB, 39 (93%) expanded polytetrafluoroethylene (PTFE) grafts and three (7%) reversed autogenous saphenous veins were used. This preponderance of PTFE results from our bias of using a prosthetic graft to the popliteal, thus saving the vein for possible future distal bypass graft. When PTFE was used, adjunctive measures such as vein cuffs or arteriovenous fistulae were not added. Warfarin anticoagulation was also not prescribed for any patients undergoing IFPB. All patients were carefully followed up with six monthly clinical, duplex, and plethysmographic evaluations, and data was analyzed by means of the Atrium Registry database.

Some degree of hemodynamic improvement was noted in all patients (ΔAnkle brachial pressure index [ABI] of 0.19 to 1.0; mean, 0.46). The mean ΔABI increase was less than the mean ΔABI of 0.61 seen in bypass grafts to nonisolated popliteal arteries with at least one vessel runoff ($P < .05$).

Three-year primary life table patency and limb-salvage rates for the 42 primary PTFE IFPBs were 73% and 86%, respectively. The location of the distal anastomosis (above or below the knee) did not affect the patency and limb-salvage rates. Arteriograms have been reviewed to assess whether there was a difference in outcome based on the runoff visualized below the isolated popliteal artery. In six patients, no named artery could be continuously visualized into the foot. However, collateral vessels extending to the foot or discontinuous major tibial arteries were shown by means of the arteriograms. Two of the IFPBs constructed in these patients failed with time (not acutely). In the remaining 36 patients, at least one leg artery suitable for bypass grafting was identified (peroneal, 56%; anterior tibial, 32%; and posterior tibial, 16%). Seven of the IFPB bypass grafts (20%) failed in this group; three of these failures occurred within 30 days.

Three patients required a subsequent reversed saphenous vein extension of the bypass graft to a tibial artery to heal gangrene that was unresponsive to the original IFPB. There were no operative mortalities. However, eight patients (19%) died within 3 years of surgery.

In a similar period, we performed 142 primary and secondary tibial and pedal bypass grafts with reversed saphenous, in situ, and arm veins. The primary patency rate at 3 years was 71%, the secondary or assisted patency rate was 82%, and the limb salvage rate was 91%. Our experience with IFPB can also be compared with our overall experience with 588 femoropopliteal bypass grafts (above- and below-knee) with at least one vessel runoff and using various graft materials, in which the 3-year primary patency rate was 78% and the limb salvage rate was 93%.

Secondary isolated femoropopliteal bypass graft. The original distal tibial reconstructions (one posterior tibial, three anterior tibial, and four peroneal) were performed for limb-threatening ischemia in all eight patients. Seven original procedures were performed at other institutions, and, accordingly, the degree of distal ischemia could only be ascertained by chart review and the patients' recollection of their foot's appearance at the time of the original operation. Six patients had nonhealing ulcers (four on the toe and two on the heel). Two patients had gangrene limited to the tip of a digit. All patients had rest pain. All original bypass grafts were constructed with ipsilateral reversed saphenous veins, and all achieved healing. Ultimately, however, these bypass grafts failed, and distal ischemic lesions recurred (three cases of gangrene of the tip of one toe and five cases of small [less than 1 cm] nonhealing foot or heel ulcers). ABIs ranged from 0 to 0.35. All eight patients were diabetic, and six were active smokers.

Another tibial artery was demonstrated to be suitable for a new distal bypass graft by means of routine angiography in two patients. However, neither patient had a sufficient useable vein for such a bypass graft. Both patients had undergone earlier coronary artery bypass grafting, and the remnant lesser saphenous and arm veins were too small. The other six patients did not have any named distal arteries. Isolated popliteal segments 7 cm or longer with at least one sural collateral were demonstrated in all eight patients.

Based on our previous experience with primary bypass grafts to an isolated popliteal segment, we elected to perform the bypass grafting procedures as secondary procedures in these eight patients (six above-knee and two below-knee). PTFE (four Goretex and four Atrium) was used for all eight grafts. Despite the limited outflow, all grafts remained patent (at follow-up examinations after 2, 2, 3, 7, 18, 32, 42, or 44 months). All pedal lesions healed, and rest pain was eliminated. ABI was improved by at least 0.25 in all patients (ΔABI = 0.25, 0.27, 0.33, 0.34, 0.36, 0.42, 0.5, 0.7).

DISCUSSION

Principles of revascularization for limb-threatening ischemia have become well established. In gen-

eral, the most proximal lesions are treated first, saving a distal procedure for failure of the more proximal operation. In infrainguinal reconstructions, this may mean performing a femoropopliteal bypass grafting procedure as the primary procedure. Distal tibial bypass grafting would then be performed only when the first procedure failed to heal the foot or when the femoropopliteal bypass graft ultimately failed and patency could not be restored by means of thrombectomy or lytic therapy. Performing a more proximal femoropopliteal bypass grafting procedure with a prosthetic, such as a PTFE graft, also has the benefit of saving the saphenous vein for the distal bypass graft, in which patency rates are appreciably lower with prosthetic grafts. In keeping with this philosophy, bypass grafting to so-called "blind" or isolated popliteal arteries has been proposed to be an effective primary procedure for infrainguinal revascularization.[1-7,9] Veith et al[2] demonstrated that if the popliteal artery was at least 7 cm long and had demonstrable collaterals, acceptable patency rates could be achieved. Mannick et al[1] and Veith et al[2,9] have shown that patency rates of 70% may equal the more privileged situation seen when more than one patent runoff artery is present. We have confirmed similar findings in our own patients. Three-year life table patency and limb-salvage rates for our isolated femoropopliteal bypass grafts were 73% and 86%, respectively. This compares favorably with our overall experience with femoropopliteal bypass grafts (above- and below-knee) with at least one vessel runoff and using various graft materials, in which the 3-year primary patency rate was 78% and the limb-salvage rate was 93%.

Veith et al[2] and Kram et al[9] demonstrated acceptable patency and limb salvage with prosthetic grafts, especially when the above-knee popliteal was the outflow artery. Corson et al[3] suggested that PTFE did not perform well for isolated popliteal bypass grafts (17% 5-year patency rate, compared with 65% for veins). However, they included only 14 synthetic grafts in their series of 65 IFPBs, five of which were not PTFE and two of which were composite grafts that failed within 5 months of surgery.

With the advances in infrainguinal reconstructions that have occurred in the last decade, the value of IFPB has again come into question. A dilemma exists between performing an IFPB or a bypass graft to a more distal tibial artery when revascularization is to be performed for rest pain or minimal tissue necrosis.[9] Most surgeons may prefer to proceed directly to tibial bypass grafting. Excellent patency rates achieved with such grafts and the improved hemodynamic results that can be expected will usually result in just one procedure being necessary. However, our preference has been to proceed with an IFPB if the popliteal is suitable. This can later be extended to the more distal tibial artery, if one is available and if the IFPB fails to achieve healing. In part, our preference is based on similar patency rates achieved by our group with isolated femoropopliteal grafts and tibial bypass grafts. Within a similar period, we performed 142 tibial and pedal bypass grafts with reversed saphenous, in situ, and arm veins. The primary patency rate at 3 years follow-up was 71%, the secondary or assisted patency rate was 82%, and the limb-salvage rate was 91%. Using a prosthetic graft for the IFPB often preserves what little vein is available for use in the tibial bypass graft. Such an extension was rarely required in our patients (three of 42, 7%), and no patient had a totally new tibial bypass graft because of failure to heal. Kram et al[9] were required to perform such additional tibial bypass grafts in only 11% of patients in their larger series. An IFPB with a prosthetic graft allows for a quick initial surgery, which may account for the low (0%) operative mortality rate seen in our patients. It should be noted that in Kram's review the operative mortality rate was higher (10%). However, it did not differentiate whether deaths were more common in IFPB performed with vein or PTFE. It is believed that the longer operative time required for vein harvest may increase operative morbidity and mortality.

There are occasions, however, when a bypass graft to the popliteal will not be constructed as the first procedure. Bypass grafts to isolated popliteal arteries may not be effective when significant limb-threatening lesions affect the foot. In such circumstances, even when the bypass graft stays patent, distal hemodynamics often do not improve sufficiently to result in healing.[2,6,10] In our patient population, ΔABI increased by a mean of only 0.46, compared with 0.61 in patients undergoing bypass grafting to nonisolated popliteal arteries. Accordingly, in the presence of significant pedal ischemia, primary distal bypass grafting may be preferable, even when an "acceptable" isolated popliteal artery is present. Furthermore, many surgeons do not perform IFPB, opting instead for a primary distal tibial bypass graft.[1-9] In such circumstances, the isolated popliteal artery may still be available for use as an outflow vessel if the primary distal reconstruction fails. Recognition of such an available artery may allow for insertion of a secondary isolated popliteal graft and limb salvage. Such an approach may be especially useful when an original tibial bypass graft improves the distal ischemia sufficiently so that only a

modest increase in perfusion is required. Secondary isolated popliteal bypass grafts are also attractive because usually the ipsilateral saphenous vein will have been used for the original tibial bypass graft. Accordingly, only limited remnants of vein may be available. These could be used for a short isolated popliteal bypass graft or jump graft extension from a prosthetic IFPB, but may not be long enough for an entirely new distal procedure. Furthermore, if vein is not available, PTFE can be used for a graft to the popliteal.

CONCLUSION

Controversy still exists about which procedure is best suited for revascularization in the presence of limited tissue necrosis or rest pain. Even when an isolated popliteal artery is present, many surgeons will favor direct tibial bypass grafting. However, in these conditions, we believe that our approach of primarily selecting the isolated popliteal for the distal anastomosis results in acceptable patency, limb-salvage, and mortality rates, without increasing the need for secondary procedures.

Our experience with eight patients also demonstrates that secondary IFPBs can be used to achieve limb salvage after failed tibial bypass grafting. Good results can be achieved, even with the use of PTFE, provided that extensive pedal tissue necrosis is not present.

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Submitted Oct 31, 1997; accepted Sep 2, 1998.